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Abstract

RADIATION-INDUCED CHANGES IN THE PROPERTIES OF NON-FUEL REACTOR MATERIALS

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The engineering properties of nuclear structural metals, including many properties that dictate the useful longevity of reactor components, have been shown to undergo drastic changes during exposure to neutron irradiation. Extensive investigations of these changes have been made in recent years. As a result, considerable understanding of observed property changes in terms of environmental parameters has been accumulated. Such understanding and its application through the formulation of radiation damage models are important for the prediction of safe material operating limits in nuclear reactors.

An increasing awareness of the roles played by the temperature at which the irradiation exposure is accumulated and the alloy content of the metal under irradiation has developed in recent years. Long-time properties as determined by in-reactor tube burst tests and postirradiation stress-to-rupture tests of certain high temperature alloys have been shown to be markedly reduced by both low temperature and high temperature irradiation exposures. While postirradiation annealing has been shown to be quite effective in eliminating transition temperature effects in ferritic steels, it has been impossible to produce recovery of irradiation effects on stress-to-rupture properties by annealing in a number of precipitation-hardening high temperature alloys.

Short-time tensile properties of Zircaloy-2, the austenitic stainless steels, and nickel-base alloys show a varied response to irradiation and irradiation temperature. In both Zircaloy-2 and the austenitic stainless steel, considerably greater room temperature strength increases and ductility reductions occur at an irradiation temperature of 290C than during similar irradiation exposure at 60C. High temperature irradiations of a precipitation-